



DECLARATION

I, Shinichi KAWASAKI of Room 704, 17-34, Miyadacho 2-chome, Takatsuki-shi, Osaka 569-1142 Japan hereby declare that I am conversant with the Japanese language and that I am the translator of the document attached and certify that to the best of my knowledge and belief the following is a true and correct English translation of the specification contained in the Priority Document No. JP 2001-321673.

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(Translation)

[DOCUMENT NAME] Specification

[TITLE OF THE INVENTION] Non-aqueous electrolyte secondary
battery

[CLAIMS]

[Claim 1] A non-aqueous electrolyte secondary
battery comprising an electrode group in which a positive
electrode plate and a negative electrode plate are spirally
wound with a separator interposed therebetween, characterized
in that

an unapplied portion is formed at one end of at
least one of said positive electrode plate and said negative
electrode plate,

said unapplied portion, which is allowed to protrude
from said electrode group, is directly connected to a current
collector plate, and

said current collector plate serves as a case bottom.

[Claim 2] The non-aqueous electrolyte secondary
battery in accordance with claim 1, characterized in that

said electrode group is inserted into a bottomless
case and said current collector plate and an opening of said
bottomless case are welded, whereby said current collector
plate serves as a case bottom.

[Claim 3] The non-aqueous electrolyte secondary
battery in accordance with claim 1, characterized in that

the thickness of said current collector plate is not less than 0.1 mm and not greater than 0.7 mm.

[Claim 4] The non-aqueous electrolyte secondary battery in accordance with claim 1, characterized in that said current collector plate is connected to said negative electrode plate, and

said current collector plate is made of nickel or a metal plated with nickel.

[Claim 5] The non-aqueous electrolyte secondary battery in accordance with claim 1, characterized in that said current collector plate is connected to said positive electrode plate, and

said current collector plate is made of aluminum, nickel-chromium steel or an alloy composed mainly of aluminum.

[DETAILED DESCRIPTION OF THE INVENTION]

[001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a non-aqueous electrolyte secondary battery, particularly to a current collecting structure.

[002]

[Prior Art]

In recent years, electronic devices such as AV equipment and personal computers are becoming portable and wireless at a rapid pace. As a power source for them, there is a growing demand for a compact and lightweight secondary

battery having high energy density. In particular, a lithium ion secondary battery using lithium as an active material is greatly expected as a battery showing high voltage and high energy density. Further, a secondary battery for power tools is required to be high-powered.

To meet the above-mentioned demands, it is important to reduce an internal resistance of a battery. In a common secondary battery, electric current is collected from a positive electrode and a negative electrode via leads, respectively.

In a high-powered nickel-metal hydride storage battery, on the other hand, electric current is collected by allowing an end of a positive/negative electrode plate to protrude from the electrode group. According to this current collecting method, the resistance can be reduced as compared to the case in which the leads are used, but it is necessary to weld the current collector plate and the bottom of the case.

[003]

[Problem That the Invention Is to Solve]

According to the current collecting method described above, if there is a hollow running through the electrode group as in a cylindrical battery, it is easy to weld the current collector plate and the bottom of the case. However, if there is no hollow running through the electrode group as in a prismatic battery, such current collecting method cannot be adopted. Further, as for the current collector plate and

the bottom of the case, because they are integrated only at the welded part, a resistance element will occur.

[004]

The present invention is intended to solve the above problems. An object of the present invention is to adopt a current collecting structure used in a nickel-hydride storage battery into lithium ion secondary batteries of any shape including prismatic batteries.

[005]

Another object of the present invention is to provide a current collecting method capable of reducing the resistance and improving the battery capacity and the battery characteristics by eliminating the volume of the current collector plate in the space inside the battery and by eliminating the bonding step of the current collector plate of either a positive electrode plate or negative electrode plate and the bottom of the case.

[006]

[Means for Solving the Problem]

To achieve the above objects, in the present invention, a current collector plate also serves as a case bottom. Further, an electrode group having a current collector plate is inserted into a bottomless case, and the current collector plate and the case are welded, whereby the current collector plate can also serve as the case bottom.

Thereby, a current collecting structure used in a

nickel metal hydride battery can be used in a lithium ion secondary battery even if the battery is prismatic. Moreover, it is also possible to reduce the resistance and improve the battery capacity and the battery characteristics by eliminating the volume of the current collector plate in the space inside the battery and by eliminating the bonding step of the current collector plate of either a positive electrode plate or negative electrode plate and the bottom of the case.

[007]

[Mode for Embodying the Invention]

The non-aqueous electrolyte secondary battery of the present invention is a non-aqueous electrolyte secondary battery comprising an electrode group in which a positive electrode plate and a negative electrode plate are spirally wound with a separator interposed therebetween, wherein an unapplied portion is formed at one end of at least one of the positive electrode plate and the negative electrode plate, the unapplied portion, which is allowed to protrude from the electrode group, is directly connected to a current collector plate, and the current collector plate serves as a case bottom.

In this battery, it is possible to reduce the volume that a conventional current collector plate has occupied in the volume of a conventional battery. By increasing the height of the electrode group, the capacity can be increased.

Further, it is possible to significantly reduce the internal resistance of the battery as compared to a battery in

which electric current is collected by leads. By reducing the internal resistance of the battery like this, polarization during charge/discharge is suppressed, and therefore battery characteristics such as charge/discharge under high load can be improved. Moreover, since Joule heat generated during charge/discharge at high current can be reduced, an increase of battery temperature during charge/discharge is inhibited.

Further, it is also preferred that the electrode group be inserted into a bottomless case and the current collector and an opening of the bottomless case be welded, whereby the current collector plate serve as a case bottom.

In this case, the current collector can easily serve as a bottom case. Further, even if the battery is prismatic, the current collecting structure used in a nickel metal hydride storage battery can be used.

In this case, the thickness of the current collector plate is preferably not less than 0.1 mm and not greater than 0.7 mm from the viewpoint of the strength of the case bottom and the conditions in which welding can be performed.

In the non-aqueous electrolyte secondary battery described above, when the current collector plate is connected to the negative electrode plate, the current collector needs to be made of a material which does not react with the electrolyte or the like at the potential of the negative electrode. Particularly, nickel or a metal plated with nickel is preferred.

Further, when the current collector plate is connected to the positive electrode plate, the current collector needs to be made of a material which does not react with the electrolyte or the like at the potential of the positive electrode. Particularly, aluminum, nickel-chromium steel or an alloy composed mainly of aluminum is preferred.

[008]

[Working Examples]

A specific example of the present invention will be described below with reference to the drawings.

[009]

FIGs. 1 to 3 are schematic diagrams illustrating the steps of the production process of a non-aqueous electrolyte secondary battery of the present invention in the order of performing the steps. Each step is schematically drawn to facilitate the understanding.

[0010]

FIG. 1 shows the structure of an electrode group having a positive electrode plate, a negative electrode plate, and a separator. A negative electrode unapplied portion 2 was formed on a negative electrode plate 1. A positive electrode plate 4 had a portion unapplied, to which an upper lead 5 was attached. The positive electrode plate 4 and the negative electrode plate 1 were spirally wound with a separator 3 interposed therebetween to form an electrode group 6. This winding was performed such that the negative electrode

unapplied portion 2 protruded from the electrode group 6.

[0011]

In FIG. 2, the unapplied protruded portion of the electrode group 6 obtained in the step of FIG. 1 was bent to be flat, to which a 0.3 mm thick current collector plate 7 made of nickel was welded by laser welding. Then, the electrode group 6 having the current collector plate 7 bonded thereto was inserted into a bottomless case 8 made of iron plated with nickel.

[0012]

In FIG. 3, the current collector plate 7 and an opening of the bottomless case 8 in which the electrode group 6 obtained in FIG. 2 was inserted were welded by laser welding. Although there are methods where the welding is performed from the direction of the bottom and where the welding is performed from the direction of the side, in this case, it was performed from the direction of the bottom. Needless to say, it may be performed from the direction of the side.

[0013]

Subsequently, recesses for clamping a sealing plate were formed, by a conventionally known method, in a battery intermediate obtained through the above steps. Then, a sealing plate was welded to the upper lead, and an appropriate amount of non-aqueous electrolyte was injected thereto. Clamp sealing was performed, and test batteries of Examples 1 to 9

were produced, which will be detailed later.

[0014]

Only an example in which the current collector plate also serving as the case bottom was connected to the negative electrode was shown here, but in the case of the current collector plate of the positive electrode serving the case bottom, appropriate materials were selected for the case and the current collector plate.

[0015]

The example showed a structure of the electrode group in which, at the bottom part, electric current was collected from the unapplied portion and, at the upper part, electric current was collected by the lead. However, at the upper part, electric current may be collected from an unapplied portion.

[0016]

For the purpose of comparison, a comparative battery A having the same structure as the above battery was produced in the same manner as above except that electric current was collected using the lead at both bottom part and upper part. Further, a comparative battery B having the same structure as the above battery was also produced in the same manner as above except that, at the bottom part, electric current was collected from the unapplied portion and the current collector plate and the case bottom were welded in the same manner as in a conventional nickel metal hydride storage battery. Further,

prismatic batteries C and D having the same current collecting structures as the comparative batteries A and B, respectively, were produced.

Next, batteries of Examples 1 to 9 produced in the above manner will be described in detail.

[0017]

(Example 1)

A cylindrical battery 1 having a size of 18650, in which a current collector plate also serving as a case bottom was connected to a negative electrode and the current collection at the positive electrode was done using a lead, was produced by the production process described above. The negative electrode active material was graphite, and the positive electrode active material was LiCoO_2 . The battery 1 was subjected to a constant current discharge at 200 mA, and the battery 1 had a capacity of 1020 mA. The internal resistance of the battery 1 measured by an alternating current method at 1 kHz was 15 m Ω , which was lower than that of the comparative battery A measured in the same manner, namely, 24 m Ω . Further, the internal resistance value was also lower than that of the comparative battery B, namely, 13 m Ω .

[0018]

Batteries also excellent in high load discharge characteristics performed by setting the discharge current to 10 A were obtained. The temperature increase at this time was 9°C lower than that of the comparative battery A.

Examples which will be described below were performed by partly changing Example 1, only changes relative to Example 1 will be described in the description of each of the following Examples.

[0019]

(Example 2)

A battery 2 was produced in the same manner as in Example 1, except that the current collection at the positive electrode was done not by a lead, but a current collector plate welded to an unapplied portion similar to that of the negative electrode. This battery had an internal resistance of 11 m Ω , lower than that of the battery 1 of Example 1, and exhibited further excellent high load characteristics.

(Example 3)

A battery 3 was produced in the same manner as in Example 1, except that the case was made using not iron, but aluminum, the current collector plate also serving as the case bottom was connected to the positive electrode, and the current collection at the negative electrode was also done using a current collector plate welded to an unapplied portion. The battery 3 had an internal resistance of 10 m Ω , and exhibited more excellent high load characteristics than those of the comparative batteries A and B.

(Example 4)

A battery 4 was produced in the same manner as in Example 1, except that the case was made using not iron, but

aluminum, the current collector plate also serving as the case bottom was connected to the positive electrode, and the current collection at the negative electrode was done using a lead. The battery 4 had an internal resistance of $20\text{ m}\Omega$, lower than that of the comparative battery A, and exhibited excellent high load characteristics.

(Example 5)

A prismatic battery 5 having the same configuration as in Example 1, and a capacity of 480 mA, a thickness of 6 mm, a width of 34 mm, a height of 50 mm was produced by constructing an electrode group for a prismatic battery. The battery 5 had an internal resistance of $30\text{ m}\Omega$, lower than those of the comparative batteries C and D, and exhibited more excellent high load discharge performance than those of the comparative batteries C and D.

(Example 6)

A prismatic battery 6 having the same configuration as in Example 3, and a thickness of 6 mm, a width of 34 mm, a height of 50 mm was produced by constructing an electrode group for a prismatic battery. The battery 6 had an internal resistance of $28\text{ m}\Omega$, lower than that of the comparative battery C, and exhibited excellent high load discharge performance.

(Example 7)

Batteries were produced in the same manner as in Example 1 except that current collector plates made of nickel

having a thickness of 0.1 mm, 0.7 mm and 1 mm, respectively, were used. The batteries using a 0.1 mm thick current collector plate and a 0.7 mm thick current collector plate had an internal resistance of 11 m Ω .

The battery production was possible using a 0.1 mm thick current collector, but considering the strength of the bottom part, the thickness of the current collector is preferably thicker than 0.1 mm. Further, the battery production was also possible using a 0.7 mm thick current collector, but, in the battery using a 1 mm thick current collector, the welding between the unapplied portion and the current collector plate did not have sufficient strength. From these facts, the thickness of the current collector is preferably not less than 0.1 mm and not greater than 0.7 mm. (Example 8)

The same batteries as in Example 7 were produced except that, as the negative electrode current collector, an iron plate plated with nickel was used. The battery production was possible using a 0.1 mm thick current collector and a 0.7 mm thick current collector. Further, the batteries had an internal resistance of 12 m Ω . (Example 9)

The same batteries as in Example 7 were produced except that the positive electrode current collector was made of an aluminum plate and an aluminum alloy containing 3% magnesium, respectively, and the current collection at the

negative electrode was done using a lead. The battery production was possible using a 0.1 mm thick current collector and a 0.7 mm thick current collector. Further, the batteries had an internal resistance of 33 m Ω .

It was confirmed that, in all the batteries obtained from Examples, a desired cycle life was ensured, good storage characteristics were obtained and the discharge capacity was improved.

[0020]

[Effects of the Invention]

As described above, according to the non-aqueous electrolyte secondary battery of the present invention, because the internal resistance of the battery can be reduced, particularly, high load discharge performance can be improved, and the temperature increase of the battery during discharge at high current can be inhibited. Further, the volume of the current collector plate is reduced, this volume can be effectively used for improving the capacity. Moreover, the current collecting method using an unapplied portion, which was not usable in a conventional prismatic battery, can be used.

[BRIEF EXPLANATION OF THE DRAWINGS]

[FIG. 1] A schematic diagram showing a first step of the production process of a battery according to the present invention.

[FIG. 2] A schematic diagram showing a second step

of the production process of a battery according to the present invention.

[FIG. 3] A schematic diagram showing a third step of the production process of a battery according to the present invention.

[Explanation of Reference Numerals]

- 1 Negative electrode plate
- 2 Negative electrode unapplied portion
- 3 Separator
- 4 Positive electrode plate
- 5 Upper lead
- 6 Electrode group
- 7 Current collector plate
- 8 Bottomless case

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(Translation)

[DOCUMENT NAME] Abstract

[ABSTRACT]

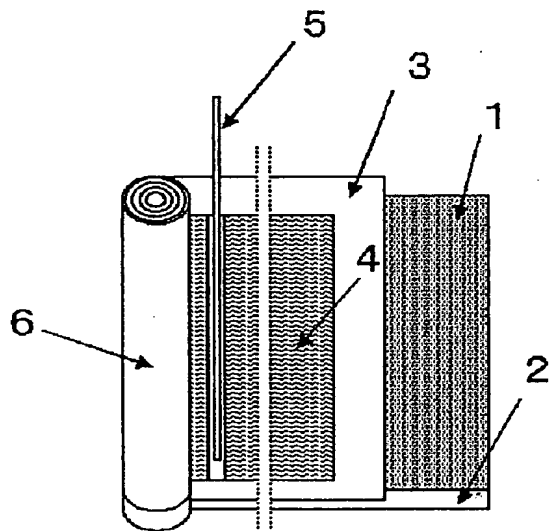
[OBJECTIVE] To provide a method for producing a battery having improved battery capacity and battery characteristics by allowing the current collector of the positive electrode plate or negative electrode plate to also serve as the case bottom.

[SOLVING MEANS] A non-aqueous electrolyte secondary battery wherein an unapplied portion is formed at one end of at least one of a positive electrode plate and a negative electrode plate, the unapplied portion, which is allowed to protrude from an electrode group, is directly connected to a current collector plate, and the current collector plate serves as a case bottom.

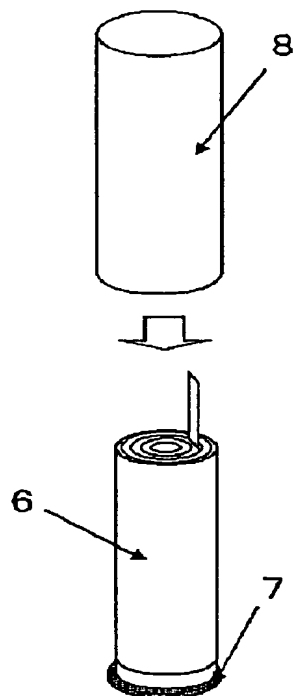
[SELECTED DRAWING] FIG. 3

【書類名】 図面 【DOCUMENT NAME】 Drawings

【図1】 【FIG. 1】



【図2】 【FIG. 2】



【図3】 [FIG. 3]

